CLAIMS

1. A human artificial chromosome vector comprising a fragment of human chromosome 21 or a fragment of human chromosome 14 from which the distal region of the long arm and/or the distal region of the short arm has been deleted.

2. The human artificial chromosome vector according to claim 1, wherein the fragment of human chromosome 21 or the fragment of human chromosome 14 is of about 2-16 Mb.

3. The human artificial chromosome vector according to claim 1 or 2, wherein the distal region of the long arm of human chromosome 21 is deleted within the 21q11 region.

4. The human artificial chromosome vector according to claim 3, wherein the distal region of the long arm of human chromosome 21 is deleted at AL163204.

5. The human artificial chromosome vector according to claim 1 or 2, wherein the distal region of the short arm of human chromosome 21 is deleted within the 21p region.

6. The human artificial chromosome vector according to claim 5, wherein the distal region of the short arm of human chromosome 21 is deleted at AL163201.

7. The human artificial chromosome vector according to claim 1 or 2, wherein the distal region of the long arm of human chromosome 14 is deleted within the 14q region.

8. The human artificial chromosome vector according to claim 7, wherein the distal region of the long arm of human chromosome 14 is deleted at AL157858 or AL512310.

9. The human artificial chromosome vector according to claim 1 or 2, wherein the distal region of the short arm of human chromosome 14 is deleted within the 14p region.

10. The human artificial chromosome vector according to claim 9, wherein the distal region of the short arm of human chromosome 14 is deleted at at least one position selected from the group consisting of OR4H12, OR4Q4, RNR2, OR4L1, RNU6C, FDPSL3, K12T, C14orf57, OR6S1, M195, OR4K14, MGC27165, LCH, OR10G3, OR4K3, OR4E2, H1RNA, ATP5C2, OR11H6 and OR4M1.

11. The human artificial chromosome vector according to any one of claims 1-10, wherein a recognition site for a site-specific recombination enzyme is inserted into the proximal region

of the long arm and/or the proximal region of the short arm of human chromosome 21 or human chromosome 14.

12. The human artificial chromosome vector according to claim 11, wherein the site-specific recombination enzyme is Cre enzyme.

13. The human artificial chromosome vector according to claim 11 or 12, wherein the recognition site for the site-specific recombination enzyme is the loxP sequence.

14. The human artificial chromosome vector according to any one of claims 11-13, wherein the recognition site for the site-specific recombination enzyme is inserted into AL163203 in the proximal region of the long arm of human chromosome 21.

15. The human artificial chromosome vector according to any one of claims 11-13, wherein the recognition site for the site-specific recombination enzyme is inserted into a more proximal position than the deletion site of AL157858 or AL512310 in the proximal region of the long arm of human chromosome 14.

16. The human artificial chromosome vector according to any one of claims 11-13, wherein the recognition site for the site-specific recombination enzyme is inserted into a more proximal position than the deletion site within the 14p12 region in the proximal region of the short arm of human chromosome 14.

17. The human artificial chromosome vector according to any one of claims 1-16, wherein the deletion of the distal region of the long arm and/or the distal region of the short arm is by substitution with an artificial telomere sequence.

18. A method for producing a human artificial chromosome vector, comprising the steps of:

(a) obtaining cells that retain human chromosome 21 or human chromosome 14;

(b) deleting a distal region of the long arm and/or a distal region of the short arm of the human chromosome 21 or human chromosome 14; and

(c) inserting a recognition site for a site-specific recombination enzyme into a proximal region of the long arm and/or a proximal region of the short arm of the human chromosome 21 or human chromosome 14.

19. The method of claim 18, wherein in step (a) the cells that retain human chromosome 21 or human chromosome 14 have high homologous recombination efficiency.

20. The method of claim 19, wherein the cells with high homologous recombination efficiency are derived from chicken DT40 cells.

21. The method of any one of claims 18-20, wherein in step (b) the deletion of the distal region of the long arm and/or the distal region of the short arm is by substitution with an artificial telomere sequence.

22. The method of any one of claims 18-21, wherein in step (b) the distal region of the long arm of human chromosome 21 is deleted at AL163204.

23. The method of any one of claims 18-21, wherein in step (b) the distal region of the short arm of human chromosome 21 is deleted at AL163201.

24. The method of any one of claims 18-21, wherein in step (b) the distal region of the long arm of human chromosome 14 is deleted at AL157858 or AL512310.

25. The method of any one of claims 18-21, wherein in step (b) the distal region of the short arm of human chromosome 14 is deleted at at least one position selected from the group consisting of OR4H12, OR4Q4, RNR2, OR4L1, RNU6C, FDPSL3, K12T, C14orf57, OR6S1, M195, OR4K14, MGC27165, LCH, OR10G3, OR4K3, OR4E2, H1RNA, ATP5C2, OR11H6 and OR4M1.

26. The method of any one of claims 18-25, wherein in step (c) the site-specific recombination enzyme is Cre enzyme.

27. The method of any one of claims 18-26, wherein in step (c) the recognition site for the site-specific recombination enzyme is the loxP sequence.

28. The method of any one of claims 18-27, wherein the recognition site for the site-specific recombination enzyme is inserted into AL163203 in the proximal region of the long arm of human chromosome 21.

29. The method of any one of claims 18-27, wherein the recognition site for the site-specific recombination enzyme is inserted into a more proximal position than the deletion site of AL157858 or AL512310 in the proximal region of the long arm of human chromosome 14.

30. The method of any one of claims 18-27, wherein the recognition site for the site-specific recombination enzyme is inserted into a more proximal position than the deletion site within the 14p12 region in the proximal region of the short arm of human chromosome 14.

31. A human artificial chromosome vector obtainable by the method according to any one of claims 18-30.

32. A cell retaining the human artificial chromosome vector according to claim 31.

33. The method of producing a human artificial chromosome vector comprising foreign DNA, further comprising, in the method according to any one of claims 18-30, the step of:

(d) inserting foreign DNA into human chromosome 21 or human chromosome 14 in the presence of a site-specific recombination enzyme.

34. A human artificial chromosome vector comprising foreign DNA that is obtainable by the method of claim 33.

35. A cell retaining the human artificial chromosome vector comprising foreign DNA according to claim 34.

36. A pharmaceutical composition that comprises the cell according to claim 35.

37. A method of introducing foreign DNA into a recipient cell, comprising the steps of:

(a) obtaining donor cells that retain human chromosome 21 or human chromosome 14;

(b) deleting a distal region of the long arm and/or a distal region of the short arm of the human chromosome 21 or human chromosome 14;

(c) inserting a recognition site for a site-specific recombination enzyme into a proximal region of the long arm and/or a proximal region of the short arm of the human chromosome 21 or human chromosome 14;

(d) inserting foreign DNA into the human chromosome 21 or human chromosome 14 in the presence of a site-specific recombination enzyme;

(e) preparing microcells from the donor cells that retain the human chromosome 21 or human chromosome 14;

(f) fusing the microcells and recipient cells; and

(g) confirming the introduction of the foreign DNA into the fused recipient cells.

38. The method of claim 37, wherein the recipient cell is an animal cell.

39. The method of claim 38, wherein the animal cell is a mammalian cell.

40. The method of any one of claims 37-39, wherein the recipient cell is a pluripotent cell.

41. The method of claim 40, wherein the pluripotent cell is an embryonic stem cell (ES cell), or a mesenchymal stem cell or a tissue stem/precursor cell.

42. A method of producing a cell that expresses foreign DNA, comprising the steps of:

(a) obtaining donor cells that retain human chromosome 21 or human chromosome 14;

(b) deleting a distal region of the long arm and/or a distal region of the short arm of the human chromosome 21 or human chromosome 14;

(c) inserting a recognition site for a site-specific recombination enzyme into a proximal region of the long arm and/or a proximal region of the short arm of the human chromosome 21 or human chromosome 14;

(d) inserting foreign DNA into the human chromosome 21 or human chromosome 14 in the presence of a site-specific recombination enzyme;

(e) preparing microcells from the donor cells that retain the human chromosome 21 or human chromosome 14;

(f) fusing the microcells and recipient cells; and

(g) selecting cells expressing the foreign DNA among the fused recipient cells.

43. The method of claim 42, wherein the recipient cell is an animal cell.

44. The method of claim 43, wherein the animal cell is a mammalian cell.

45. The method of any one of claims 42-44, wherein the recipient cell is a pluripotent cell.

46. The method of claim 40, wherein the pluripotent cell is an embryonic stem cell (ES cell), or a mesenchymal stem cell or a tissue stem/precursor cell.

47. A method of producing a protein, comprising the steps of:

(a) obtaining donor cells that retain human chromosome 21 or human chromosome 14;

(b) deleting a distal region of the long arm and/or a distal region of the short arm of the human chromosome 21 or human chromosome 14;

(c) inserting a recognition site for a site-specific recombination enzyme into a proximal region of the long arm and/or a proximal region of the short arm of the human chromosome 21 or human chromosome 14;

(d) inserting foreign DNA encoding a protein into the human chromosome 21 or human chromosome 14 under the expression of the site-specific recombination enzyme;

(e) preparing microcells from the donor cells that retain the human chromosome 21 or human chromosome 14;

(f) fusing the microcells and recipient cells;

(g) incubating the fused recipient cells in culture media; and

(h) collecting the protein from the resultant culture.

48. The method of claim 47, wherein the protein is selected from the group consisting of erythropoietin (EPO), thrombopoietin (TPO), blood coagulation factor, von Willebrand factor (vWF), dystrophin, dopamine synthase, insulin, insulin-like growth factor (IGF), insulin-like growth factor binding protein (IGFBP), antibody, telomerase, granulocyte colony stimulating factor, granulocyte/macrophage colony stimulating factor, immunoglobulin, growth hormone, interleukin 2, interleukin 3, interleukin 4, interleukin 5, interleukin 6, interleukin 7, interleukin 8, interleukin 9, interleukin 10, interleukin 11, interleukin 12, interleukin 15, CD40 ligand, interferon, adenosine deaminase, alpha-1 antitrypsin, ornithine transcarbamylase, purine nucleotide phosphorylase, growth inhibiting factor (GIF), tumor necrosis factor (TNF), leukemia inhibitory factor (LIF), oncostatin M, Flt3 ligand (Flt3L), stroma derived factor (SDF), stem cell growth factor (SCF), fibroblast growth factor (FGF), epidermal growth factor (EGF), vascular endothelial growth factor (VEGF), angiopoietin, nerve growth factor (NGF), bone morphogenetic factor (BMP), activin, transforming growth factor (TGF) and Wnt.